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THE VISCOSITY OF RUBBER SOLUTIONS.

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During the last few years, several interesting papers on the viscosity of rubber solutions have been published, chiefly with a view to proving the existence of some relationship between the viscosity of such a solution and the strength or physical and mechanical qualities of the raw or vulcanised rubber.

If such a relationship be found to exist, we have a very useful and rapid method of ascertaining the value of any particular sample of rubber from one species such as Para (Hevea).

On theoretical grounds such a relationship might be expected to exist, especially if we accept the idea that rubber (caoutchouc) is built up of different polymers or, to use a less strictly scientific expression, different physical aggregates of the same substance, since the word "polymer" has a definite meaning in scientific language, whereas the actual existence of "polymeric" substances in raw caoutchouc is surmised but by no means proved. Each polymer or physical aggregate would possess a definite viscosity in solution at any particular concentration.

At the present stage it is not possible to state definitely whether there exists any correlation between such viscosity and the mechanical properties of the vulcanised rubber, since this has been both asserted and contradicted by different investigators.

Viscosity determinations carried out by the writer and other experimenters have however yielded results which are very suggestive and which appear to indicate such a relationship.

Thus, the deterioration of the physical properties and the production of "tackiness" in raw rubber by heat, light or chemical agents such as copper sulphate and other copper and metallic salts is indicated well by the results of viscosity determinations. The effect of excessive rolling on the washing machines is also indicated in the same way.

One of the most complete papers on the subject, which have been published hitherto is that by H. G. Fol, Chemical Engineer and Officer-in-Charge of the Government Rubber Testing Station, Delft, Holland, printed in the India Rubber Journal and also in French, German, and Dutch periodicals. This contains a critical survey of the methods proposed for the determination of viscosities and experiments showing the effects of various factors on the results obtained.

It is proposed to outline the experiments made and the conclusions deduced from these, and to offer a few criticisms based on the results of the writer's own work on the same subject. The results obtained by the writer and quoted on pages 52 & 53 of Bulletin 17 Department of Agriculture have now been calculated by both Schridowitz's and Fol's methods and are appended.

In the first place, the author is to be congratulated on his foresight in suggesting that viscosity determinations should be carried out at a temperature of 30°C, since workers in the tropics would have been unable to compare their figures with those obtained in temperate climates, for, as will be shown later, temperature has a marked effect on the results. It is often difficult in the tropics to carry out experiments at a lower temperature than that of the surrounding atmosphere, as ice or other methods of cooling are not always available, whereas it is always comparatively simple to raise and maintain a slightly higher temperature. (The average shade temperature in the laboratory in this country is about 27°C).

The experiments and observations may be summarised as follows :—

1. An examination of the various methods proposed for the determination of viscosities.
2. Conclusions as to the most desirable method.
3. Influence of size, etc., of viscometer on the results.
4. Influence of temperature.
5. Relationship between age of solution and viscosity.
6. Effect of different methods of preparation of the raw rubber.
7. Effect of method of preparation of the solution.
8. Method of calculation to be adopted as a standard.

The sample of raw rubber used in the experiments was a sample of plantation para crepe from Java, coagulated by means of acetic acid, and yielding the following analytical figures, which may be considered normal.

Water.	0. 1 per cent.
Mineral ash.	0. 3 per cent.
Resin.	3.1 per cent.
Protein.	1.35 per cent.

The conclusions drawn by the author on the results of his experiments are as follows :—

1. The use of the Ostwald capillary tube viscometer is recommended as the most suitable.

2. The dimensions of the viscometer have a considerable influence on the results obtained, so that the work of different experimenters is not comparable, unless a standard instrument is used.

3. The temperature at which the viscosity determinations are made has a marked effect on the results; increased temperature decreases the absolute viscosity, but the relative viscosity, *i.e.*, the viscosity of the solution at any temperature compared with the viscosity of the solvent at the same temperature is constant. No effect is produced by warming a solution and again cooling—the viscosity remains constant at the lower temperature when redetermined. A standard temperature of 30°C is recommended, to enable the results obtained by workers is the tropics to be compared with those obtained in temperate climates.

4. The age of the solution after preparation has a marked effect on the viscosity in some, but apparently not in the case of all rubbers. The viscosity of concentrated solutions of rubber decreases with age, and especially when exposed to light. In the case of very dilute solutions, little or no decrease occurs. The decrease may be caused by the aggregation and deposition of the finely divided insoluble particles in suspension, which cannot be filtered by ordinary methods. The decrease due to light, especially ultra-violet rays, proves that the suspended particles cannot be the only cause.

5. The mechanical treatment of the rubber before dissolving has a marked effect on the results.

The viscosity of solutions was found to decrease when the rubber was washed between rollers and converted to crepe, the decrease being more or less proportionate to the period of treatment.

6. It was found that partial solution of the rubber, by allowing samples to remain for an insufficient time in the solvent gave lower viscosities. Three theories are advanced to account for this phenomenon; (1) the resins, which have a lower viscosity than the caoutchouc dissolve more readily and are therefore present in greater proportion in a partial solution; (2) the caoutchouc may be a mixture of polymers, the lower of which having a lower viscosity, dissolve first and are therefore present in greater proportion; (3) the caoutchouc may be a mixture in varying states of aggregation of the same chemical substance.

It is therefore recommended that the rubber should remain in the solution till only the insoluble portion, protein, etc., remains in suspension and all the caoutchouc is completely dissolved.

7. Mechanical treatment of the solution, by shaking, etc., was also found to influence the results, the shaken solutions having a higher viscosity, which may be due to the larger proportion of small invisible particles which remain in suspension.

Another interesting point observed was the influence of the cappillary bore of the viscometer on the results, the time of flow in second and subsequent observations being decreased.

8. A new method of calculating the absolute viscosity of a solution was given and that put forward by Schridowitz previously was criticized.

Conclusions:—The following modus operandi was recommended. Quantities of 1.00, 0.50, and 0.25, grammes of rubber are weighed out, after cutting into small pieces and drying in a vacuum dessicator and are dissolved each in 100 ccs. of pure benzene (B.P.80°C) in brown glass bottles. The solutions are shaken twice a day by hand and filtered through glass wool after 3 days. The solution is then allowed to stand for another day and if a deposit occurs, again decanted. The exact concentration of each solution is obtained by evaporation of an aliquot portion of each solution in a basin. After 4 days the viscosity of each solution is determined at 30°C in an Ostwald viscometer of standard dimensions. (*N.B.* The standard is not given.)

The efflux time is calculated from the mean of three observations in each case and the value reduced to relative viscosity. A viscosity curve is then drawn from the figures obtained on standard paper on which 1 cm. on abscissa = 0.1% concentration and 1 cm. on ordinate = 2 viscosity units. The "absolute viscosity" by Fol's method = Area (in square cms.) enclosed by abscissa, curve, and the ordinate at 1% concentration. (This is measured by a planimeter or by weighing, if standard paper is used.)

Criticisms :—

I agree with the author in his recommendation of the Ostwald viscometer as the most suitable instrument for carrying out viscosity tests and that a temperature of 30°C is the most convenient especially for workers in the tropics, where it may be difficult to obtain ice or other means of cooling the solutions. I am unable to agree with his proposal that the mean of three observations at each concentration, should be taken, on account of the decrease in viscosity caused by passing the solution through the capillary bore. This is not only very laborious, but merely introduces another unnecessary factor into the results. Again I am unable to agree as to the method of preparation of the rubber sample, a point on which many investigators are at variance.

In order to compare, for manufacturing purposes, any one sample with another, it appears to be more fair to dissolve each sample in the state in which it is used in the vulcanizing factory, *i. e.* all samples should be converted to thin crepe. For scientific purposes, this is unnecessary, since one may be comparing sheet with crepe, or thin crepe with thick crepe, or smoked with unsmoked, etc., in which case the samples should be only cut up and dried in a dessicator and subjected to as little mechanical treatment as possible.

It is obviously unfair to compare a piece of pure plantation crepe, which can be used directly, without further treatment in the factory, with a sample from a ball of Fine Hard Para which has to be steamed and softened and creped in heavy macerating machines and dried before it can be used, since if a comparison is made before such treatment it would be much more in favour of the latter rubber, and incorrectly so.

One factor which may cause the reduction of viscosity of partial solutions appears to have been overlooked by Fol, viz. that, when a sample is partially dissolved, nearly all the invisible insoluble fine particles are probably retained in the rubber structure till solution of the caoutchouc is complete, as the rubber is seen to retain its original structure, although swollen by the solvent, till the final stage of solution.

In the preparation of the rubber solution, I have found that accuracy is obtained by making an approximately 1 per cent. solution in pure benzol, in long cylinders, decanting or pipetting off the clear supernatant layer above the insoluble particles (filtering only when the solution appears turbid or opalescent) and estimating the rubber in an aliquot portion of the clear solution by evaporation in a flat porcelain basin. More dilute solutions are made by accurate dilution in narrow graduated cylinders (usually 10 or 20cc. cylinders) and the concentration calculated. The figures obtained invariably fall on the curve obtained from figures by making up separate solutions of each concentration as suggested by Fol, which is very laborious and unnecessary.

The method of calculation of results given by Fol has much to recommend it, as the tangent method of Schridowitz and Goldsborough, although in many cases it places samples of rubber in the same order of merit as Fol's method, is open to the objection that a tangent to the curves is difficult to construct accurately, as even a difference of one degree in the angle for curves of high viscosity solutions gives a great difference in the results. I believe the tangent method, if the curves were drawn with great accuracy, would give valuable results, but it involves the personal equation to too great an extent, whereas slight inaccuracies in the construction of

the curve, when Fol's method of calculation is used, have only a small effect.

Viscosity Results Obtained by the Writer.

I have appended to this review, the results of my own experiments given on pages 52 & 53 of Bulletin 17 Department of Agriculture, F.M.S., and have now calculated the absolute viscosities by both Schridowitz's and Fol's methods, adding the order of merit of the samples in a second table. It will be seen that quite a number of these coincide for both methods of calculation and many others nearly so.

The instrument used was an Ostwald viscometer having an efflux time for pure benzene of 20 seconds, the determinations being made at approximately 27°C, the ordinary laboratory temperature.

					Absolute viscosity Schridowitz's method.	Absolute viscosity Fol's method.
1	(a)	1.01,	0.76,	0.50, 0.25	162.0	69.5
	(b)	52.8 ,	23.4 ,	10.2 , 3.6		
2	(a)	1.00,	0.75,	0.50, 0.25	83.3	53.5
	(b)	36.0 ,	17.4 ,	8.1 , 5.1		
3	(a)	1.02,	0.76,	0 50, 0.25	93.0	57.3
	(b)	41.7 ,	18.6 ,	9.0 , 3.6		
4	(a)	1.00,	0.75,	0.50, 0.25	80.0	54.0
	(b)	36.3 ,	20.7 ,	8.4 , 3.3		
5	(a)	1.01,	0.76,	0.50, 0.25	108.0	57.5
	(b)	43.2 ,	19.8 ,	9.3 , 3.6		
6	(a)	1.00,	0.75,	0.50, 0.25	86.6	49.0
	(b)	34.5 ,	16.5 ,	8.1 , 3.3		
7	(a)	1 00,	0 75,	0.50, 0.25	94.0	55.2
	(b)	37.2 ,	19.8 ,	8.4 , 3.3		
8	(a)	1.00,	0.75,	0.50, 0.25	126.0	51.6
	(b)	38.1 ,	17.4 ,	8.7 , 3.3		
9	(a)	0.78,	0.39,	0.19	72.0	48.8
	(b)	10.5 ,	5.7 ,	3.0		
10	(a)	0.71,	0.35,	0.18	147.0	116.7
	(b)	35.1 ,	8.4 ,	3.3		
11	(a)	1.01,	0.76,	0.50, 0.25	19.5	19.6
	(b)	12.3 ,	7.8 ,	4.2 , 2.4		
12	(a)	1.00,	0 75,	0.50, 0.25	72.0	47.3
	(b)	30.6 ,	17.1 ,	7.5 , 3.3		
13	(a)	0.93,	0.70,	0.46, 0.23	58.0	40.2
	(b)	22.5 ,	12.3 ,	6.0 , 2.7		
14	(a)	0.97,	0.73,	0.48, 0.24	162.0	65.1
	(b)	48.0 ,	20.7 ,	8.7 , 3.3		
15	(a)	0.92,	0.70,	0.46, 0.23	16.8	13.0
	(b)	7.5 ,	4.8 ,	3.0 , 1.8		

								Absolute viscosity Schridowitz's method.	Absolute viscosity Fol's method.
16	(a)	0.71,	0.53,	0.35,	0.18			102.8	76.0
	(b)	18.6 ,	15.0 ,	6.3 ,	3.0				
17	(a)	1.00,	0.75,	0.50,	0.25			152.0	63.6
	(b)	48 0 ,	21.0 ,	9.3 ,	3.6				
18	(a)	1.00,	0.75,	0.50,	0.25			85.0	49.0
	(b)	32.7 ,	16.8 ,	7.8 ,	4.2				
19	(a)	1.00,	0.75,	0.50,	0.25			134.0	66.4
	(b)	45.9 ,	22.8 ,	9.6 .	3 6				
20	(a)	0.96,	0.72,	0.48,	0.24			80.2	53.7
	(b)	32.4 ,	16.8 ,	8.4 ,	3.0				
21	(a)	0.95,	0.71,	0.48,	0.24			90.2	57.1
	(b)	34.2 .	17.7 ,	8.1 ,	3.3				
22	(a)	1.00,	0.75,	0.50,	0.25			80.2	52.9
	(b)	34.8 ,	18.3 ,	8.1 ,	3.2				
23	(a)	1.00,	0.75,	0.50,	0.25			286.0	83.6
	(b)	63.6 ,	28.5 ,	11.4 ,	3.9				
24	(a)	1.00,	0.75,	0.50,	0.25			94.0	59.8
	(b)	39.6 ,	21.0 ,	9.0 ,	3.3				
25	(a)	0.92,	0.70,	0.46,	0.23			94.0	53.6
	(b)	30.3 ,	15.6 ,	7 8 ,	3.0				
26	(a)	1.50,	1.12,	0.90.	0.75,	0.37		92.0	78.3
	(b)	219.6 ,	84.9 ,	39 9 ,	27.3 ,	7.2			
27	(a)	1.45,	1.22,	1.09,	0.87,	0.77,	0.36	138.0	60.5
	(b)	170.4 ,	85.8 ,	62.7 ,	30.9 ,	21.3 ,	5.7		
28	(a)	1.29,	1.16,	1.09,	0.97,	0.77,	0.65, 0.32	328.0	123.9
	(b)	202.5 ,	115.2 ,	97.8,	76.8 ,	37.2,	21.6 , 6.0		
29	(a)	1.09,	0.98,	0.87,	0.82 ,	0.55,	0.27	228.0	96.6
	(b)	95.7 ,	65.0 ,	47.4 ,	39.3 ,	15.9 ,	4.8		
30	(a)	1.26,	1.13,	1.01,	0.88,	0.75,	0.64, 0.38	260.0	109.3
	(b)	194.1,	131.1,	89.7 ,	58.5 ,	36.6 ,	21.9, 9.6		
31	(a)	1.15,	1.03,	0.92,	0.69,	0.46,	0.23	254.0	106.1
	(b)	154.8 ,	100.8,	63.9 ,	27.3 ,	11.4 ,	4.5		
32	(a)	0.99,	0.89,	0.79,	0.69,	0.49,	0.30	238.0	109.3
	(b)	91.5 ,	63.0 ,	40.8 ,	28.7 .	15.6 ,	5.7		
33	(a)	1.00,	0.80,	0.60,	0.40,	0.20		6.5	8.2
	(b)	4.8 ,	3 6 ,	2.7 ,	2.1 ,	1.5			
34	(a)	1.52,	1.37,	1.22,	0.91,	0.61,	0.30	173.0	71.4
	(b)	186.0 ,	133.8 ,	88.2 ,	42.0 ,	15.3 ,	5.1		
35	(a)	1.70,	1.36,	1.02,	0 85,	0.68,	0.51	190.0	105.8
	(b)	699.0 ,	279.6 ,	84.3 ,	54.9 ,	28.2 ,	10.5		
36	(a)	1.44,	1.15,	0.86,	0.58			27.0	24.4
	(b)	30.3 ,	18.6 ,	11.1 ,	6.0				
37	(a)	1.49,	1.19,	0.89,	0.60,	0.30		58.0	38.3
	(b)	70.2 ,	36.3 ,	18.9 ,	9.0 ,	3.6			
38	(a)	1.45,	1.30,	1.16,	0.87,	0.58,	0 29	27.0	46.3
	(b)	87.3 ,	62.1 ,	44.1 ,	21.9 ,	9.9 ,	3.9		

							Absolute viscosity Schridowitz's method.	Absolute viscosity Fol's method.
39	(a)	3.61,	1.52,	1 41,	1.13,	0.85	3.9	6.4
	(b)	27.9 ,	6.9 ,	5.7 ,	4.2 ,	3.3		
40	(a)	1.5 ,	1.35,	1.20,	0.90,	0.75, 0.60	286 0	96.0
	(b)	362.7 ,	234.9 ,	150.9 ,	55.2 ,	27.6 , 18.3		
41	(a)	2.2 ,	1.76,	1.32			3.2	3.8
	(b)	9.9 ,	6.9 ,	4.8				
42	(a)	0.85,	0.76,	0.68,	0.34		37.6	40.8
	(b)	17.7 ,	16.8 ,	17.9 ,	4.8			
43	(a)	1.42,	1.14,	0.85,	0.57,	0.28	79.6	43.7
	(b)	66.9 ,	42.3 ,	19.5 ,	9.3 ,	3.9		
44	(a)	1.47,	1.18,	0.88,	0.59		3.5	6.2
	(b)	5.4 ,	4.2 ,	3.0 ,	2.4			
45	(a)	1.43,	1.29,	1.14,	0.86,	0.57	116.0	56.6
	(b)	120.6 ,	76.5 ,	58.0 ,	25.5 ,	11.7		
46	(a)	1.46,	1.17,	0.89			3.0	5.7
	(b)	4.5 ,	3 6 ,	2.7				
47	(a)	1.47,	1.32,	1.18,	0.88,	0.59	254.0	64.4
	(b)	160.8 ,	105.6 ,	72.9 ,	31.5 ,	12 9		
48	(a)	1.45,	1.30,	1.16,	0.87,	0.58	254 0	69.0
	(b)	157.8 ,	106.8 ,	73.5 ,	32.4 ,	12.9		
49	(a)	1.41,	1.27,	1.13,	0.85,	0.56	173.0	65.4
	(b)	131 7 ,	95.1 ,	64.5 ,	29.7 ,	12.3		

Note:—a = Percentage concentration of solution.
b = Relative viscosity.
Benzene = 1.

Order of Merit.	Schridowitz's Method. No. of sample.	Fol's Method. No. of sample.
1	28	28
2	23	10
3	40	30
4	30	32
5	31	3
6	47	35
7	48	29
8	32	40
9	29	16
10	35	14
11	34	23
12	49	26
13	1	34
14	14	1
15	17	48
16	10	19
17	27	49

Order of Merit.	Schridowitz's Method. No. of sample.	Fol's Method. No. of sample.
18	19	47
19	8	17
20	45	27
21	5	24
22	16	5
23	24	3
24	25	21
25	7	45
26	3	7
27	26	4
28	21	20
29	6	25
30	18	2
31	2	22
32	20	8
33	22	6
34	4	18
35	43	9
36	9	12
37	12	38
38	13	43
39	37	42
40	42	13
41	36	37
42	38	36
43	11	11
44	15	15
45	33	33
46	39	39
47	44	44
48	41	46
49	46	41

From the history of the samples and the nature of the curves my opinion is that Fol's method of calculation gives more reliable results, and more in accordance with facts.

FUNGICIDES; THEIR PREPARATION AND APPLICATION.

(*Continued*)

A. SHARPLES.

Fungicides containing Sulphur as a basis upon which the Fungicidal quality depends ;

Since the period when Agriculturists and Horticulturists commenced using chemical solutions against the ravages of Fungi, solutions containing Sulphur in some form have always been recognised as of value. In fact, during the last decade, the advances made have not been in the direction of discovering better spraying solutions, but rather along the line of correcting the proportions of the materials used, and also in the application of the mixture. The early investigators upon this subject fully recognised the value of the principal ingredients of our up-to-date spraying solutions, and if the early literature of the subject is looked up, one finds, Copper, Sulphur, and Lime, the stock ingredients, of our spraying solutions at the present time, much in evidence as component parts of their mixtures. Bordeaux mixture, as such, has long been known. The increased value of this mixture as a fungicide has resulted through improvements in the spraying machine.

In many cases, it is dangerous to use Bordeaux mixture, due to the fact that the application of this mixture results in injury to the foliage. In these cases, a combination of Lime and Sulphur, known as the Lime-Sulphur mixture, often proves of value. In the case of many diseases, caused by fungi commonly known as "Mildews," as in the case of the Hop Mildew, the application of the Lime Sulphur wash is of special value.

Sulphur is usually applied either in powdered form, such as "Flowers of Sulphur," or as soluble Sulphur in the form of "Livers of Sulphur" or Lime Sulphur Wash.

For present purposes, nothing more than mere mention of the first two is necessary.

Flowers of Sulphur.

"Flowers of Sulphur" is often valuable to the Horticulturist as a specific against Plant Disease. The application is usually made by dusting the powder over the leaves as equally as possible when the dew is upon them, or after being moistened artificially. Under the heat of the sun, SO_2 is generated, and to this compound is due the Fungicidal quality, Hot summery weather is necessary for the successful working of this compound.

Livers of Sulphur.

"Livers of Sulphur" usually consists of a mixture of Polysulphides of Potassium and Sodium. In applying the substance to diseased plants, 1 oz. is usually dissolved in 2 to 3 gallons of water. This solution will not keep.

Lime-Sulphur Spray.

This mixture will probably prove of value in combating "Pink Disease." Bordeaux mixture cannot be used in this connection, unless applied very carefully as a "paint." The Lime-Sulphur" spray can be used either as a "spray" or a "paint," and in any case, it is much the safer mixture to use amongst Rubber. Many enquiries for the method of preparation reach the Department, and so the preparation of this mixture will be fully considered. The information as regards preparation is derived from a leaflet issued by the South Eastern Agricultural College, entitled "Lime Sulphur Wash" by E. S. Salmon.

The wash is prepared by boiling Lime and Sulphur with Water. Chemical reaction takes place, bringing about the solution of the Lime and Sulphur.

Recent chemical investigations have shown the following formula to be the best.

Quicklime (in lumps)	48	lbs.
Flowers of Sulphur	96	,,
Water	50	galls.

Good fresh Quicklime must be used, as otherwise the concentrate will not be of the desired density. Some form of heating apparatus is necessary, either made of iron or zinc: *Copper ones cannot be used.*

Preparation.

The wash is prepared as follows:—

10 galls. of water are poured in the heating apparatus, and the fire started. Then the 48 lbs. of Quicklime is added. When the slaking is well started, add the 96 lbs. of Sulphur gradually, and mix until a thin even paste is formed, taking care to break up all the small lumps of Sulphur as far as possible. If too thick a little more water may be added. When thoroughly mixed add water to make up to 50 galls., *boil vigourously for one hour*, stirring frequently and adding water when necessary to keep it at the same level.

The wash thus prepared (on settling) will be a clear orange red liquid, most of the Lime and Sulphur becoming dissolved during the boiling. A small amount of Lime and Sulphur remaining undissolved.

The wash is most conveniently prepared in concentrated form, later, on using, to be diluted with water to the required strength.

The most convenient method of preparation for planters inclined to use this wash, will be to utilise a kerosene tin, in which to boil the mixture. Sufficient concentrated wash could thus be obtained, using a 4 gall. kerosene tin, for any planter to test the

efficiency of the wash. The approximate proportions of materials, under these conditions would be :—

Quicklime (in lumps)	... ...	4 lbs.
Flowers of Sulphur	... ...	7½ ,,
Water	...	4 galls.

1 gall. of water should be placed in the tin, and the fire started. Then add the 4 lbs. of Quicklime. Later, following the instructions given above, the Sulphur is added, and finally the water.

The resulting liquid must be strained, and stored immediately where air cannot reach the liquid. If kept in air-tight receptacles this concentrated wash will keep until wanted for use.

The concentrated wash requires to be diluted before it can be used upon foliage. For this reason, the Specific Gravity of the liquid should be determined by means of a hydrometer. The Sp. Gr. of the concentrate will vary considerably, due chiefly to differences in the Lime used, and also to details connected with boiling. A good Lime Sulphur Wash will have a Sp. Gr. of about 1.20.

For use on foliage water should be added until it has a Sp. Gr. of 1.01, when the wash may be termed full strength, or further diluted until it has a Sp. Gr. of 1.005 for the half strength wash. One gallon of the concentrate.l of 1.20 Sp. Gr. will make 20 galls. of full strength wash, (1.01 Sp. Gr.), or twice the amount of half strength (1.005 Sp. Gr.).

So that if 4 galls. of the concentrated wash is made up in a kerosene tin, and the given instructions followed, this amount ought to give 80 galls. "full strength" wash. This "full strength" wash will be of most service against "Pink Disease."

Firms of repute are now placing upon the market a factory boiled concentrated Lime Sulphur wash of Sp. Gr. 1.300. One gallon of such a wash will make 30 galls. "full strength" wash.

Recent investigations in the U S. of America indicate that the fungicidal qualities of the Lime Sulphur Wash are considerably increased if Arsenate of Lead is added. This compound is placed on the market as Swift's "Arsenate of Lead" paste, and should be added to the Lime Sulphur Wash at the rate of 2 lbs. to 50 galls. Also, what is of importance, the value of the "Arsenate of Lead" as an insecticide is not interfered with.

Application.

The "full strength" wash may either be sprayed or painted on the infected branches. In connection with spraying, copper spraying machines must not be used as the liquid reacts chemically with the metal. A fine nozzle must be used. Painting the infected patches, on trees attacked by *Corticium Javanicum* with the concentrated wash will probably prove of value.

GUTTA PERCHA FROM PALAQUIUM OBLONGIFOLIUM.

Gutta Percha is derived principally from trees growing within a few degrees of the equator and is an important product in the Fed. Malay States. The gutta percha of commerce may be obtained from the latex which exudes from the trees by cutting or tapping as in the case of Hevea latex, etc., and subsequent coagulation.

Gutta Percha is usually understood to refer to the coagulated latex from the Genus Palaquium (also known as Dichopsis.)

The best gutta percha in this country is derived from *Palaquium oblongifolium*, known by the Malays as Taban Merah.

The Conservator of Forests has stated that this tree (*Palaquium oblongifolium*), is found in all four States, although many of the older trees in the virgin jungle have been destroyed by felling by natives, in order to obtain the latex. It occurs principally on the low lying hills and plains but is often found at elevations of 2000-3000 feet about sea level and may occur regularly distributed in afew hundred acres of forest, or in large areas of 10,000-15,000 acres. The Conservator of Forests in the Agricultural Bulletin S.S. and F.M.S. for 1905 states that the trees grow to a large size and he has measured a fallen tree 52 feet high and 42 inches girth at 14 feet from the base.

Attempts have been made within recent years to establish nurseries or to plant up through rentices in the jungle.

Methods of production :—The natives usually fell the trees and extract the latex by very crude and wasteful methods, and regulations for the protection of the trees have been made from time to time, since the formation of a Forest Department. Among these measures were a high (80 per cent.) ad valorem duty, the prohibition of felling, and the withdrawal of licences. To encourage the growth of the young trees, which is rather slow, the surrounding jungle is cleared from time to time and young plants from fallen seeds, transplanted in certain places.

Methods of extraction of latex :—The latex from the trees exudes immediately on tapping or cutting the bark and resembles Hevea latex in general appearance. It coagulates quickly and becomes reddish pink—probably due to an oxidising enzyme in the latex—on standing.

The natives, as stated above, formerly felled the trees and cut circular incisions at short distances apart, round the trunk, from which the exuded latex—which had coagulated naturally, was removed.

The crude product obtained in this way naturally contains bark, dirt, etc., and was sometimes washed and pressed into blocks.

A tree about 50 years old, measuring 3 inches in girth at 4 feet from the base with a height of 55 feet and branching at 35 feet,

when treated in this way, under supervision, yielded only 1½ lbs. of gutta percha.

Various other methods such as extraction from the leaves, twigs and bark—have been tried, especially in Java. The green leaves are stated to contain 3 per cent. and the bark 5 per cent. of gutta percha.

Properties and uses :—The chief property of gutta percha—as compared with raw rubber is its plasticity and capacity for being moulded into any shape especially when softened by heating.

Its principal use is as an insulating material for submarine cables, as it is unaffected by the conditions prevailing.

It is also stated to be preferable for this purpose to rubber, as it is often less porous on vulcanisation. It was probably formerly used to a greater extent for land cables, where cheaper materials, such as papier machè, etc., have been substituted.

Commercial gutta percha contains principally "Gutta" resembling "Caoutchouc" chemically but not physically., and resins known as "Albanes" with other impurities, water. etc.

REPORT ON A SAMPLE OF GUTTA PERCHA :—

The following report from Prof. Wyndham Dunstan C.M.G. Director of the Imperial Institute is based on an examination of the product obtained by tapping the standing trees of the *Palaquium oblongifolium* sent to the Imperial Institute by the Conservator of Forests S.S. and F.M.S.

Description of sample :—The sample consisted of blocks of gutta percha, of a pinkish grey colour on the exterior and paler within. The material was clean and well-prepared and possessed satisfactory physical qualities.

Results of chemical examination :—

The chemical examination yielded the following results :—

	per cent.
Loss on Washing (moisture and impurities.)	20.9
Composition of dry washed gutta percha.	
Gutta	85·7
Resins	13·1
Protein	0·7
Ash	0·5

The above analysis shows that the gutta percha is of very good quality chemically, the loss on washing however being rather high, chiefly on account of the presence of much water.

The solid impurities ("dirt") are however very low, being only 3.3 per cent. in the dry material.

Tensile strength :—The tensile strength of the sample was ascertained by a manufacturing firm with the following results :—

Tensile strength ... 2,607 lbs. per sq. inch.
Elongation .... 415 per cent.

These figures were stated to be not quite so good as the best gutta percha obtained in the ordinary way, but all the other properties of the material compared favourably with those of the best gutta percha.

Valuation :—The sample was valued at 6/- (six shillings) per lb. by one firm (February 1913) and 7/6 (seven shillings and six pence) by another firm (April 1913). It was also valued at 3/- to 4/- (three to four shillings) per lb. by brokers (January 1913), who stated that it was difficult to give a valuation in the absence of technical trials.

One firm stated that they doubted whether the amount of "dirt" could be kept so low when preparing large samples.

Conclusions :—The Director states that, as a result of these examinations, it is evident that the gutta percha obtained by tapping standing trees is of good quality and could command satisfactory prices in the market.

B. J. E.

RUBBER MANURIAL EXPERIMENTS (JAVA.)

In a bulletin* recently issued from the agricultural chemical laboratory of the Department van Landbouw, Java, over the name of Dr. A. W. K. de Jong, appear the results of some experiments on the influence of manuring on the girth increase of Hevea trees, an account of which may be of interest.

The number of trees employed was 336, of which 252 had not previously been tapped. All were very backward in growth owing to the fact that no weeding system had been adopted.

The whole plantation was intersected by trenches 1½ feet deep and 1 foot broad so that each tree stood as it were on a square island.

The planting distances differed considerably. Trees 1-71 were planted 18 × 18 ft.; 72-175, 16 × 16 ; 176-230, 28 × 28 : and the remainder 12 × 24.

A series of seven manurial tests was carried out, one plot remaining untreated. To equalise the differences due to planting, etc., the trees were divided up into groups of 4, each experiment thus being carried out on 10½ of these groups. The initial girths were measured at a height of 1 metre (39.4 inches) from the ground, and the combined girths of the 42 trees in the various plots at the beginning of the trial (April 3rd 1911) were as follows :—

*Mededeelingen van het Agricultuur Chemisch Laboratorium No. IV. Hevea brasiliensis, Wetenschappelijke proeven, door Dr. A. W. K. de Jong.

I	II	III	IV	V	VI	VII	VIII	
1336·5	1302	1383	1430	1406	1426	1394·5	1368	centimetres
516	512	544½	563	553½	561	549	538½	inches.

The age of the trees was 6 years, *i. e.*, 5 years 4 months from the planting out of the stumps.

The following fertilisers were applied in a circle of radius 1 metre from the tree.

I Double superphosphate 30 grams per tree.
II „ „ „ + chloride of potash 10 grams.
III „ „ „ + sulphate of ammonia 10 grams
IV The same + both chloride of potash (10 grams) and sulphate of ammonia (10 grams.)
V Chloride of potash 10 grams.
VI „ „ „ + sulphate of ammonia 10 grams.
VII Sulphate of ammonia 10 grams.

This application was made on 12 April and a second similar one on July 19. The trees were measured again on 20 November. and shewed the following increases:—

I	II	III	IV	V	VI	VII	VIII	
146·5	144·5	146·5	157·5	152	154	153	140·5	cms.
57·7	56·9	57·7	62·0	59.8	60.6	60·2	55·3	inches,

On Nov. 24 a fresh application of double the above quantities of the fertilisers was made and again on 25 January, 1912. On 8 April, 1912, fresh measurements were taken when the following increases over the original were found:—

I	II	III	IV	V	VI	VII	VIII	
295	287	291·5	319	293·5	304·5	318·5	280	cms.

Following this were made further applications on 1 May and 2 August of similar mixtures in which the amounts of double superphosphate, chloride of potash, and sulphate of ammonia were 50, 50, and 100 grams respectively.

The final girths recorded were taken on 17 November, 1912, and were as follows (increases over original):—

I	II	III	IV	V	VI	VII	VIII
392	377·5	394	421	394·5	417·5	415	368

The net increases over the control plot were therefore

		Cms.		Inches.
I	Phosphate	24	=	9·4
II	Phosphate + Potash	9·5	=	3·7
III	Phosphate + Nitrogen	26	=	10·2
IV	Phosphate + Potash + Nitrogen	53	=	20·9
V	Potash	26·5	=	10·4
VI	Potash + Nitrogen	49·5	=	19·5
VII	Nitrogen	47	=	18.5

De Jong proceeds to point out that although the increase obtained from using nitrogen alone is hardly less than that derived from the complete fertiliser (IV) yet, as certain amounts both of potash and of phosphate are removed from the tree in the latex, it is still possible, that applications of these last mentioned substances may prove profitable and he hopes subsequently to decide this point.

In addition to the author's own criticism that the number of trees employed was too small for the results to be completely satisfactory the following remarks may be added :—

No information is given relating to the composition of the soil in which the trees were growing, but if, as the reviewer believes, the experiments were carried out at Buitenzorg, it is considerably poorer in nitrogen, through being for centuries under cultivation, than that on which are situated most of the Malayan estates, but on the other hand is richer in phosphate.

The extreme smallness of the size of the trees (averaging at 6 years only 12·9 inches in girth 3ft. 3in. from the ground) is testimony to the poverty of the soil and to the influence of the weeds in which, it is stated, the trees were growing.

It would have been better had the plots been limed before manuring, as, apart from the possible need of lime in the soil, this measure has been proved by Pickering in the Woburn experiments to be efficacious in destroying the toxins invariably secreted by weeds, de and grass. As it is, it is not unlikely that the actual effect of the various manures on the trees in these experiments is partially obscured by their action on the toxins.

The quantities of fertiliser applied, amounting in all to only 1·8 oz. nitrogen, 2½ oz. potash (K_2O) and 1·8 oz. phosphoric acid (P_2O_5) per tree seem too small, considering the age of the trees, to afford very definite results and are in fact less than would be used in actual practice.

It will be noted that the maximum increase in girth obtained, that brought about by the complete fertiliser, averages barely ½ inch per tree.

Also, as a minor point it may be suggested that it would have been preferable to have made the plot having the *highest* initial girth the control, and to have applied the complete fertiliser, from which the greatest increase was to be expected to that in which the average girth was originally the lowest, in order to anticipate the possible objection that the same influences which had caused these differences might still be in operation.

In other respects however the experiments were well arranged.

M. B.

MINUTES OF MEETING OF THE PLANTERS' ASSOCIATION OF MALAYA, HELD AT JOHORE HOTEL, JOHORE BAHRU, ON JULY 13th, 1913, AT 10.30 a.m.

Present.

R. W. Munro — Chairman.
G. H. Day — Legal Adviser.
H. C. E. Zacharias — Secretary,

and the following Delegates from the various constituent Associations :—

H. E. Darby.	Batang Padang Planters' Association.
Neill Mackinnon.	Johore Planters' Association.
E. D. Bryce.	do. do.
A. L. Buyers.	do. do.
A. Voeterdal.	do. do.
J. Bruce.	do. do.
E. Macfadyen.	Kuala Langat District Planters' Association.
G. C. Ash.	do. do.
E. B. Skinner	Kuala Lumpur District Planters' Association.
F. Zernichow.	Lower Perak Planters' Association.
J. W. Campbell.	Malacca Planters' Association.
C. Ritchie.	Negri Sembilan Planters' Association.
W. D. Davidson.	do. do.
A. S. Crisp.	do. do.
F. J. Lloyd.	Negri Sembilan Planters' Association.
P. W. N. Farquharson.	do. do.
E. A. Tayler.	do. do.
W. E. Stephens.	Singapore Planting Association.
E. Granville Smith.	Ulu Selangor District Planters' Association.

Hon. Members :—

L. Lewton-Brain.	Director of Agriculture.
C. Lane Sansom.	Principal Medical Officer.
E. S. Hose.	Ag. Controller of Labour.

Visitors :—

E. Gordon, A. S. Chilvers, M. MacKenzie.

London, 1914, Exhibition.

A letter from the Under Secretary, Federated Malay States, was read promising the co-operation of the Federated Malay States Government with regard to this Exhibition provided the planting community undertook to raise £1,000 towards the expenses.

A letter from Mr. C. Baxendale urging participation was also read.

A draft circular was approved in which estates were asked to contribute at the rate of eight cents per acre of cultivated land.

Batavia Exhibition.

It was decided to join with the Federated Malay States Government in sending a commission to the Batavia Exhibition and Congress.

Repression of Drunkenness.

The Honourable Mr. Skinner stated that he had recommended to Government the appointment of a technical Committee to consider the question of the alcoholic strength of toddy and the harm this drink was causing. He moved that Government should be asked to make it an offence not only to *sell* but to *give* spirits to Indian labourers and also for Indian labourers to be in possession of them.

Mr. Macfadyen seconded and the motion was carried unanimously. The Secretary is directed to address the Colonial, Federal and Johore Governments accordingly.

Honorary Members.

Mr. Munro on behalf of the Standing Committee proposes the following addition to the Rules :—

" All members, who shall have served the office of Chairman of " the Association for at least one year shall become Honorary " Members of the Association."

This is seconded by Mr. Campbell and carried unanimously. Mr. Munro gives notice that he will propose at the next meeting the election of the Director of Gardens, Straits Settlements, as a Honorary Member.

Education on Estates.

The Secretary reports in the replies he has received from the various District Planters' Associations with regard to the number of estates that are providing or are making provision to provide Education for Tamil children.

The Chairman reads a letter he had addressed to the Under Secretary with regard to the hours during which it was suggested the Estate schools should be open.

After some discussion it was decided to leave the matter with the Standing Committee.

Labour Code.

Mr. Macfadyen on behalf of the Standing Committee submits a report on debated points connected with the Labour Code of 1912 and it appears that a settlement, which on the whole the Planters' Association of Malaya might regard as a favourable one, was in sight.

The Chairman thanks the Standing Committee for their work in this connection.

He also propose a vote of thanks to the Rubber Growers' Association for their assistance.

Both votes are carried with acclamation.

Extradition of Absconders.

Mr. Campbell raises the question of the extradition of absconding coolies from Johore to Malacca and points out that there is no law preventing coolies walking across the border and taking service on the other side.

It was unanimously agreed that representations be made to the Colonial, Federal and Johore Governments to make absconding an extradictable offence.

Tamil Holidays.

A list of Tamil Holidays suggested by the Controller of Labour is read. The Secretary reported that he had suggested some modifications.

Date of Payment of Wages.

Correspondence with regard to this is read and the Honourable Mr. Skinner reports on his action at the Federal Council.

Mr. Macfadyen suggests that the Association promote a private bill to be brought before the Federal Council at the next session and similarly before the Legislative Council and proposes that the whole matter be referred to the Standing Committee. This is agreed to.

Standardization of Rubber.

Correspondence with regard to this is read and the Secretary reports that he has thanked the Government for the ready manner in which it had acceded to the representations made by the Association.

Licensing Rubber Dealers.

The Secretary reads a letter he has addressed to the Colonial Secretary, Straits Settlements and the Under Secretary, Federated Malay States, pointing out that few benefits have been derived from the law owing to the fact that no special machinery has been provided to administer it.

Machinery Enactment.

The Honourable Mr. G. H. Day outlines the principal amendments which had been secured in the Machinery Enactment. The original draft said that after a serious accident all machinery had to

stand still until an inspector had seen it. That had been amended to provide that no alterations or additions should be made to the machinery. They had also secured an appeal to the Resident from a decision of the Chief Inspector.

Malay Reservation Enactment.

The Honourable Mr. Skinner reports that in view of the strong opinion held by the Sultans, the unofficial members had decided not to oppose the measure.

Agricultural Pests Enactment.

The Honourable Mr. Skinner summarises the action taken by the Federal Government. The Director of Agriculture states that to carry out the Enactment, a Chief Inspector and three assistant Inspectors had already been appointed, while the appointment of the fourth Assistant Inspector provided for had not yet been made.

As to the question of locusts the Government Entomologist, though he was too busy to report fully, had devised measures which under certain circumstances, at any rate, were successful in dealing with this pest. He believed that the Government would be willing to take the matter in hand thoroughly, once practical methods for destruction had been devised.

Mr. Campbell hopes that the Colony would introduce similar legislation to the Agricultural Pests Enactment.

The Chairman congratulates the Director of Agriculture on the progress made and thanks the unofficial members for their good offices in connection with the Machinery and Pests Enactments.

Freight on Rubber.

Correspondence referring to this is read and the meeting decides to approach the Rubber Growers' Association with a view to taking up the matter with the shipping Conference.

Agricultural Bulletin.

The question of the arrangement between the Department of Agriculture and the Planters' Association of Malaya with regard to the *Agricultural Bulletin* is brought up for discussion.

The Chairman eulogises the excellent work done. The Bulletin filled a real want and, as it was supplied free to every member of all Constituent Associations, had become a powerful link, binding the Parent and Daughter bodies together.

He had much pleasure in proposing the renewal of the present working arrangement for another year.

Mr. Bryce seconds the motion and only regrets that more planters did not contribute to the Bulletin. Surely the old idea of secrecy and every man for himself was exploded. What they all wanted, was to work together and compete, not against each other, but against the wild forms of rubber.

The proposal was carried unanimously.

LOWER PERAK.

Mr. Zernichow describes the deplorable state of the Water Supply, Roads and Drainage in the Telok Anson District. Matters had grown simply intolerable, and none of their many complaints and representations to Government had ever improved matters. He had been delegated by his Association to ask the Planters' Association of Malaya for their assistance and he now begged to propose that the Standing Committee visit the District and enquire into the whole matter.

Mr. Macfadyen seconds the proposal, which is carried unanimously.

With a vote of thanks to the Chair, the meeting terminates at 1.30 p. m.

Sgd. H. C. E. ZACHARIAS.

Secretary.

BAGAN DATOH PLANTERS' ASSOCIATION.

A meeting of the above association was held at the resthouse on June 25th, preceded by a committee meeting.

Present, Messrs. T. T. Beaty Pownall, (chairman) Gillespie, Phillips, Counsel, Manchip, Lawford, Davidson, Alexander, Pratt, Carter, and visitor, Mr. A. W. Wilson.

The minutes of the last meeting were read and passed. The circular letter from the Planters' Association of Malaya, re. "Education on Estates," was read, and the chairman spoke to the effect that it would be as well to get figures from members at once.

It was resolved that the secretary write to individual members for the figures required by the parent Association.

Mr. Lawford, in a short speech, urged the great importance of the damage by rats in the District which Mr. Counsel heartily endorsed. Mr. Lawford proposed, and Mr. Counsel seconded "That the Agricultural Department be approached in person, in regard to the pests of rats and caterpillars." On Mr. Pownall's suggestion, a deputation, consisting of the chairman and Messrs. Counsel, Davidson and Lawford, was appointed, to interview the Director of Agriculture on the subject at the earliest possible date. Carried.

A notice from P. A. M. re. Recruiting was read and Mr. Gillespie said he would like to see uniformity in the district both in regard to pay and recruiting allowances. He suggested, that for the first 6 months, a man should be rated at 40 cents, and a woman 25 cts., to be raised to 45 cts. and 30 cts. respectively. Messrs. Phillips and Counsel spoke in support. Mr. Counsel further suggested, that in view of the size of the district, it would be advisable to approach the Lower Perak P. A. with a view to combined action being taken. After further discussion Mr. Counsel proposed that the matter be referred to the committee to draw up regulations, (to which the members of this association agreed to adhere), and to arrange a meeting with the Lower Perak Association at the earliest date possible. It was proposed that Messrs. Counsel and Davidson be asked to serve on the committee in this matter. Seconded by Mr. Gillespie, and carried unanimously.

A letter was read from the Lower Perak P. A. announcing a meeting on July 5th, to consider the best means of communication between Teluk Anson and Sitiawan. The chairman proposed that the secretary write accepting the invitation, and urged members to turn up in force.

Mr. Counsel then addressed the meeting on the subject of the "State of the Roads and Drains in the District," and suggested that a member of the Federal Council be approached with a view to his visiting the district, and seeing the state of affairs for himself.

The chairman proposed, as an alternative, that the planting member be asked to come down. Mr. Lawford suggested that Mr. Munro as chairman of the P. A. M. be written to, with a view to obtaining a visit from a planting member of the Federal Council at an early date. This was seconded by Mr. Phillips, and carried unanimously.

Mr. Counsel proposed, and Mr. Phillips seconded, "That the minutes of meetings be sent to the papers."

Mr. Lawford proposed, and Mr. Counsel seconded, "That the minutes be sent to the *Agricultural Bulletin, F.M.S.* Carried.

Mr. Counsel proposed, "That the secretary write to the District Officer, Lower Perak, strongly urging that a magistrate be sent to Bagan Datoh, to sit at least once a week for the purpose of dealing with labour cases."

Mr. Davidson pointed out the hardship and loss of time entailed under existing conditions owing to the necessity of going to Teluk Anson, 25 miles away, to prosecute absconding and other coolies. Mr. Lawford spoke to the same effect, and seconded the motion, which was carried.

Mr. Lawford proposed "That the Secretary write to the State Engineer, asking for an up-to-date plan of all drainage works, com-

pleted, or in course of construction, in the district." This was seconded by Mr. Davidson, and carried.

The meeting terminated with a vote of thanks to the chair.

F. T. MILLARD.

BURR FORMATION.

In the preliminary note on this subject in last month's Agricultural Bulletin it was suggested that burrs on rubber trees originate as the result of irritation set up by some substance present in the cells of the cortex. It has since been discovered that this substance is the coagulated latex in old laticiferous vessels. This gives rise to burrs in both untapped and renewing bark.

A full account will be published in due course.

E. BATESON.

SOIL ANALYSES.

Managers desiring analyses made of soils of their estates for the purpose of arranging manurial trials, etc., are requested not to take the samples themselves but to communicate with the Director of Agriculture, who will arrange that the officer in charge of soil work shall visit the estate, take the samples and make the necessary notes on conditions, etc., himself.

DEPARTMENTAL NOTES.

Mr. P. B. Richards, Assistant Agricultural Inspector, Department of Agriculture, F.M.S., arrived at Kuala Lumpur and assumed his duties on 30th June (A. B. Vol. I. No. 11, p.413).

NOTICE.

An Index to the First Volume of the *Agricultural Bulletin, F.M.S.*, is in course of preparation and will be issued shortly to all subscribers.

FEDERATED MALAY STATES.

Comparative Statement of Cultivated Rubber Exported, with Value and Duty Collected Thereon, during the Years 1913 and 1912.

Places of Destination.	Exported during June, 1913.	Previously.	Total export during the year.	Export during similar period of previous year.	Increase.	Value of rubber, 1913, to date.	Duty collected, 1913, to date.
	Tons.	Tons.	Tons.	Tons.	Tons.	$	$
Straits Settlements ...	1,212.08	3,472.67	4,684.75	2,713.61	1,971.14	14,524,459	361,347.54
United Kingdom ...	674.03	4,221.78	4,895.81	3,485.23	1,410.58	15,562,153	389,053.82
Continent of Europe ...	81.88	527.75	609 63	467.85	141.78	1,960,424	49,010.60
Ceylon	37.96	255.21	293.17	200 39	92.78	946,314	23,657.85
Other Countries ...	...	...	...	...	...	...	...
Total ...	2,005.95	8,477.41	10,483 36	6,867.08	3,616,28	32,993.350	823,069.81

KUALA LUMPUR,
5th July, 1913.

W. J. P. HUME,
Commissioner, Trade and Customs, F.M.S.

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of June, 1913.

DISTRICT.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	TEMPERATURE.				HYGROMETER.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Khota Bahru	...	147.	...	91.23	74.43	16.80	...	.968	78.3	.83	...	6.68	1.72
Malacca, Durian Daun Hos.	29.850	133.6	81.9	87.5	72.8	14.7	79.2	.962	...	.88	N. W.	8.94	2.55
N. Sembilan, Dist. Hospital Seremban	...	147.6	79.9	87.3	71.6	15.7	76.1	.823	74.6	.81	S. W.	8.47	1.31
,, Dist. Hos. K. Pilah	...	148.2	80.8	89.3	74.5	14.8	76.7	.842	74.	.80	...	5.92	1.05
,, ,, Tampin	...	154.1	80.2	88.2	74.2	14.	76.1	.822	73.2	.79	...	5.02	1.15
,, ,, P. Dickson	...	152.2	82.0	87.9	74.6	13.3	77.7	.866	74.8	.79	...	13.98	1.87
Pahang, ,, K. Lipis	...	...	81.4	89.6	69.2	20.4	75.5	...	...	...	...	6.67	2.59
Penang, ,, Penang	29.777	143.	83.1	89.7	74.4	15.3	77.6	.881	74.6	.78	...	10.47	3.25
Perak, ,, Taiping	...	108.	82.91	94.	70.	24.	78.09	.896	...	.81	...	11.85	3.67
,, ,, Ipoh	...	...	82.	92.	71.	21.	77.12	.868	...	.81	...	15.33	4.28
,, ,, T. Anson	...	...	82.65	92.	69.	23.	79.53	.966	...	.87	...	5.62	1.90
,, ,, P. Buntar	...	...	82.18	92.	71.	21.	77.69	.889	...	.83	...	7.84	2.50
,, The Cottage	...	...	...	...	...	...	...	...	...	...	...	18.46	4.55
Selangor, General Hospital Kuala Lumpur	...	146.	80.9	88.9	72.5	16 4	77.6	.879	75.3	.82	...	3.77	1.22
,, Dist. Hos. Klang	...	...	...	88.2	73.5	14.7	...	...	...	...	...	5.96	2.00
,, ,, K. Selangor	...	...	...	88.2	70.3	17.9	...	...	...	...	...	6.35	2.40
,, ,, Rawang	...	...	...	91.3	72.7	18.6	...	...	...	...	...	6.24	1.88
Singapore, Kandang Kerbau Observatory	29.896	155.	82.2	91.4	72.	19.4	76.2	.896	...	.82	S. E.	12.81	3.65